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OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

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MEMORANDUM **February 17, 2010**

SUBJECT: Drinking Water Exposure Assessment for Current Uses of Oxamyl

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This assessment quantifies potential surface water exposure due to the maximum use patterns of ten currently labeled uses of oxamyl (bananas/plantains, celery, eggplant, ginger root, peanuts, pears, pineapples, sweet potatoes, tobacco, and yams) that were not quantitatively assessed in the 2009 refined drinking water exposure assessments conducted for the proposed use on sugar beets (DP barcode 351367; USEPA, 2009) and the proposed label amendment for use on dry bulb onions and garlic (DP barcode 363404; USEPA, 2009a). The previous 2009 assessments included the other twelve of twenty-two currently labeled uses (*i.e.*, apples/apple thinning [treated as a single use for exposure assessment], citrus, non-bearing fruit, carrots, cucumber group, garlic, onions, peppers, potatoes, tomatoes, cotton, and peppermint/spearmint), which were selected for surface water exposure assessment based on high usage and/or high

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annual application rate. This assessment does not include ground water exposure assessment because the 2009 assessments completed the ground water exposure analysis for all currently labeled uses.

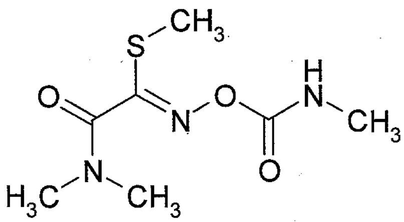
Oxamyl is currently registered for uses grown in Hawai'i (pineapple and ginger root) and Puerto Rico (pineapple and yams). Unique characteristics of Hawaiian and Puerto Rican soils give rise to large uncertainties in estimating the environmental fate and transport of oxamyl in those areas. Environmental fate studies conducted on Hawaiian and Puerto Rican soils are needed to further assess the environmental fate of oxamyl on and in soils of use sites in Hawai'i and Puerto Rico. Specifically, an acceptable aerobic soil metabolism study, batch equilibrium study, and terrestrial field dissipation study conducted with Hawaiian and Puerto Rican soils of typical pineapple, ginger, and yams use sites would enable more accurate estimates of exposure.

The surface water advisory on the current end-use labels (EPA Reg. No. 352-532 and 352-372; Vydate® L and Vydate® C-LV) does not represent the currently recommended advisory language. For example, it addresses ground spray applications and does not address aerial spray applications. The December, 2006 Label Review Manual prescribes the following language for surface water label advisories:

> "*This product may impact surface water quality due to runoff of rain water. This is especially true for poorly draining soils and soils with shallow ground water. This product is classified as having high potential for reaching surface water via runoff for several days to months after application. A level, well-maintained vegetative buffer strip between areas to which this product is applied and surface water features such as ponds, streams, and springs will reduce the potential loading of oxamyl from runoff water and sediment. Runoff of this product will be reduced by avoiding applications when rainfall is forecasted to occur within 48 hours.*"

Labeled application rates are limited by season. While for most labeled crops there is one growing season per year, onions and celery may be cropped two to three times per year and spearmint may be harvested twice per year (USEPA, 2007). Therefore, one could conclude that onions, celery, and spearmint have multiple seasons per year and that annual application rates for use on these crops could be multiples of the labeled seasonal application rates. This would result in exposure higher than that estimated for celery in this assessment and for onions and spearmint in the 2009 assessments. Also, onions and celery are often rotated with other crops throughout the year in order to reduce pest pressures; however, they may be rotated with other crops for which oxamyl is registered for use, which would negate any estimated reduction in exposure due to crop rotation. Due to the complexity of assessing multiple crops per year with current models that require use pattern inputs on an annual basis, exposure resulting from multiple seasons per year was not evaluated in this or prior assessments. This assessment assumes that exposure from use on crops with multiple seasons per year is not intended; if this is not the case, this assessment underestimates potential exposure. If our assumption is an accurate interpretation of the label, changing labeled application rate restrictions from a seasonal basis to an annual basis for all uses (and particularly for use on celery, onions, and spearmint), would resolve this ambiguity in the label directions.

Drinking Water Exposure Assessment for Current Uses of Oxamyl



Oxamyl

CAS# 23135-22-0 PC Code 103801

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1. EXECUTIVE SUMMARY

This assessment quantifies potential surface water exposure due to the maximum use patterns of ten currently labeled uses of oxamyl [(*EZ*)-N,N-dimethyl-2-methylcarbamoyloxyimino-2-(methylthio)acetamide; CAS# 23135-22-0; PC Code 103801], which are bananas/plantains, celery, eggplants, ginger roots, peanuts, pears, pineapples, sweet potatoes, tobacco, and yams. These uses were not quantitatively assessed in previous refined drinking water exposure assessments conducted in 2009 in which ground water exposure assessment was completed for all current uses (DP barcode 351367; USEPA, 2009 and DP barcode 363404; USEPA, 2009a).

Exposure estimates from the currently labeled maximum use patterns, adjusted with applicable national or regional percent cropped area (PCA) values and using current models, are listed below in **Table 1.1**. Tier I modeling was conducted for use on ginger, pineapple, and yams because Tier II model scenarios (including surrogates) were not available with which to analyze these uses that occur in Hawai'i and/or Puerto Rico. However, provisional Tier II modeling (described in **Section 3.3.2.1**) was conducted for these uses in order to refine the exposure estimates; results are listed in **Table 3.11** rather than in **Table 1.1**. Tier II modeling was conducted for use on bananas/plantains, celery, eggplants, peanuts, pears, sweet potatoes, and tobacco. The 30-year daily time series of EDWCs that Tier II point estimates in **Table 1.1** represent will be transmitted with this assessment to the Health Effects Division (HED) for probabilistic modeling in support of human health dietary risk assessment.

Table 1.1. Estimated Drinking Water Concentrations (EDWC) from Maximum Use Patterns of Oxamyl (values >80 μg/L are bolded).

Drinking Water Source (model/data source)	Use (modeled rate)	PCA[A]	1-in-10-Year Peak[B] (μg/L)	1-in-10-Year Annual Mean[B] (μg/L)	30-Year Mean (μg/L)
Surface water (FIRST)	Ginger (8.0 lbs a.i./A/year)	100%	**279**	6.6	--
	Pineapple (8.0 lbs a.i./A/year)	100%	**593**	14	--
	Yams (4.0 lbs a.i./A/year)	100%	**218**	5.1	--
Surface water (PE)	Banana/plantain (4.0 lbs a.i./A/year)	100%	**204**	6.3	2.3
	Celery (6.0 lbs a.i./A/year)	82%	**138**	5.2	2.7
	Eggplant (6.0 lbs a.i./A/year)	85%	**237**	9.1	3.6
	Peanut (4.0 lbs a.i./A/year)	87%	55	2.3	1.6
	Pear (2.0 lbs a.i./A/year)	87%	41	1.3	0.41
	Sweet potato (6.0 lbs a.i./A/year)	87%	59	1.9	0.82
	Tobacco (2.0 lbs a.i./A/year)	87%	7.2	0.25	0.18

A PCA means "percent cropped area." A PCA of 100% was applied to uses in areas outside the contiguous United States. The default national PCA of 87% was applied to uses within the contiguous United States with EDWCs <80 μg/L. Default regional PCAs (82% and 85%) were applied to the remaining uses.

B Peak and annual mean exposure estimates for PE are 1-in-10-year values.

The Tier I surface water drinking water peak exposure estimates for these oxamyl uses ranged 218-593 μg/L. The Tier II 1-in-10-year peak exposure estimate for use on bananas and plantains in Puerto Rico (modeled with the Puerto Rico coffee scenario as a surrogate) was similar, at 204 μg/L. Tier II acute exposure estimates for uses in the contiguous United States ranged up to 237 μg/L upon refinement with regional PCAs and scenarios specific to these uses or to similar uses (*i.e.*, surrogate scenarios). Chronic (1-in-10-year annual mean) EDWCs ranged up to 9.1 μg/L for Tier II modeling of uses in the contiguous United States and up to 14 μg/L for Tier I modeling of uses in Hawai'i and Puerto Rico. Monitoring data discussed in the 2009 assessment for the proposed use on sugar beets (DP barcode 351367; USEPA, 2009) indicate that oxamyl has been detected in surface water at up to 2.8 μg/L in vulnerable areas.

Lime softening reduces oxamyl concentrations in drinking water by 99% (Miltner, 2005); activated carbon filtration reduces oxamyl concentrations by only 20 to 38% (Speth and Miltner, 1990). Other drinking water treatment methods are not effective (USEPA, 2007*a*).

The main transformation products of oxamyl, oxime [methyl-2-(dimethylamino)-N-hydroxy-2-oxoethanimidothioate] and dimethyloxamic acid [DMOA; (dimethylamino)oxoacetic acid] are more mobile and more persistent than the parent, however environmental fate data are too limited to properly assess and characterize their fate in the environment. These degradates were determined in the IRED not to be of toxicological concern (USEPA, 2000). The remaining major degradates of oxamyl, DMCF and DMEA, are possible degradates of oxamyl oxime and are not structurally similar to oxamyl parent. Therefore, they are not considered to be of toxicological concern. As a result, oxamyl alone is the residue of concern in drinking water.

2. PROBLEM FORMULATION

This drinking water assessment uses modeling to provide estimates of surface water concentrations of residues in drinking water source water (pre-treatment) resulting from oxamyl use on vulnerable sites according to current labels. This assessment includes ten currently labeled uses (bananas/plantains, celery, eggplant, ginger root, peanuts, pears, pineapple, sweet potatoes, tobacco, and yams) that were not quantitatively assessed in the 2009 refined drinking water exposure assessments conducted for the proposed use on sugar beets (DP barcode 351367; USEPA, 2009) and the proposed label amendment for use on dry bulb onions and garlic (DP barcode 363404; USEPA, 2009a). The previous 2009 assessments included the other twelve of twenty-two currently labeled uses (*i.e.*, apples/apple thinning [considered a single use for exposure assessment], citrus, non-bearing fruit, carrots, cucumber group, garlic, onions, peppers, potatoes, tomatoes, cotton, and peppermint/spearmint), which were selected for surface water exposure assessment based on high usage and/or high annual application rate.

EDWCs reflect drinking water exposure to residues of concern for oxamyl, which the Interim Reregistration Eligibility Decision (IRED) for oxamyl identified as the parent compound alone (USEPA, 2000). Primary routes of transport to surface source water include runoff, erosion, and spray drift. Leaching into ground water is not analyzed in this assessment because the refined drinking water exposure assessments conducted in 2009 completed the ground water exposure analysis for all currently labeled uses.

In this assessment, the Tier II PE model (including PRZM and EXAMS) is used to assess surface water exposure due to runoff, erosion, and spray drift from uses for which model scenarios or surrogate model scenarios are available (*i.e.*, bananas/plantains, celery, eggplant, peanuts, pears, sweet potatoes, and tobacco). Exposure in surface water from uses that cannot be modeled with PE because a reasonable surrogate scenario is unavailable (*i.e.*, ginger root, pineapple, and yams in Hawai'i and/or Puerto Rico) is estimated using the Tier I FIRST model and further characterized when exposure estimates exceed 80 µg/L. This screening cut-off concentration of 80 µg/L was used because previous dietary risk assessment indicated that dietary levels of concern (for food plus water and accounting for number of eating occasions per day) were not exceeded when exposure estimate time series were represented by a 1-in-10-year peak value below 80 µg/L (personal communication with Sheila Piper, Nov. 19, 2008).

3. ANALYSIS

3.1. Use Characterization

Maximum use patterns for the ten currently labeled uses that are analyzed in this assessment are listed in **Table 3.1**. The listed use patterns are the maximum use patterns allowed on current labels and do not include all labeled use patterns and application methods that are labeled for these uses.

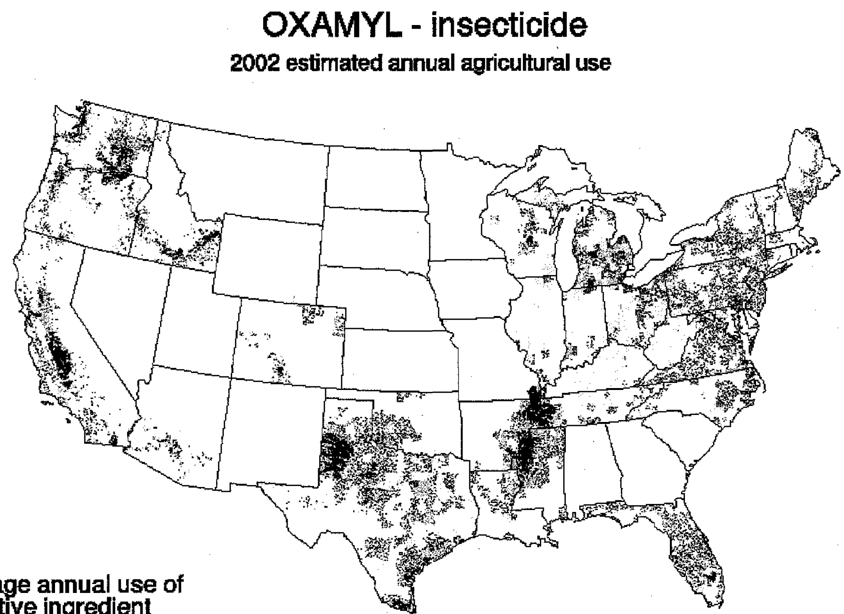
Table 3.1. Maximum Use Patterns for the Assessed Uses of Oxamyl.[A]

Use Pattern	Formula	Geographic Applicability	Single App. Rate (lbs a.i./A)	Max. Number of App.	Seasonal App. Rate (lbs a.i./A)	App. Interval (days)	App. Method
Banana/plantain	Vydate® L	PR only	4.0	1	4.0	N/A[B]	Ground
			1.3	3	4.0	21, 60[C]	Chemigation
Celery	Vydate® L	AZ, CA, FL only	1.0	6	6.0	5	Aerial/ground
		FL, OH, PA, MI, TX	2.0	3		21	Ground
Eggplant	Vydate® L	United States	1.0	8	6.0	7	Ground
		Except CA	2.0			28, 14, 7[D]	
Ginger root	Vydate® L	HI only	4, 1[E]	8	10	30	Ground
Peanut	Vydate® L	Excludes CA	0.5	8	5.0	14[F]	Aerial/ground
	Vydate® C-LV						
Pear	Vydate® L	Excludes CA	2.0	1	2.0	N/A	Ground
Pineapple	Vydate® L	Excludes CA	2.0	8	8.0	14	Ground
Sweet potato	Vydate® L	Excludes CA	4.0	2	6.0	No min.	Ground
Tobacco	Vydate® L, Vydate® C-LV	United States	2.0	1	2.0	N/A	Ground
Yam	Vydate® L	PR only	0.5	8	4.0	14	Ground

A Listed use patterns represent maximum use patterns and do not represent all labeled application methods for these uses.
B N/A means "not applicable".
C The second application occurs 21 days after the first and is followed by a third application 60 days later.
D Initial two applications at 2.0 lbs a.i./A are soil treatments 28 days apart. Two foliar applications at 1.0 lb a.i./A, 7 days apart, follow 14 days after the initial two soil applications.
E The first value is for a pre-plant application; the second value is for following post-plant applications.
F Interval is 14 days for the second application and not provided for later applications.

Labeled seasonal application rates are treated as annual application rates in this assessment. However, this may underestimate exposure from crops with multiple seasons per year, such as celery. Although celery is typically rotated with other crops throughout the year rather than consecutively grown in the same field in order to reduce pest pressures (University of California, 2009), the crops rotated in (*e.g.*, onions) may be labeled for oxamyl use, which lends uncertainty to the exposure estimates for these uses.

Figure 3.1 presents the national agricultural usage pattern of oxamyl in 2002 (USGS, 2010). At that time, cotton received 49% of national usage, followed by potatoes at 27%, and other crops, each at <7% of national usage. Use on cotton and potatoes was assessed in the 2009 refined drinking water exposure assessment conducted for the proposed use on sugar beets (DP barcode 351367; USEPA, 2009). Celery is the only crop evaluated in this assessment for which data were reported; it received 1.8% of national usage. A Screening Level Usage Analysis (SLUA) of oxamyl (dated June 5, 2009) based on source data from 2001 to 2007 indicated that in these years potatoes received 43% of national usage, followed by cotton (29%), and other crops at 8.6% or less of national usage (USEPA, 2009b). Celery, peanuts, and tobacco are the crops evaluated in this assessment that were listed in the SLUA, with respective national usage percentages of 2.9%, 0.43%, and 0.14%.



Average annual use of active ingredient (pounds per square mile of agricultural land in county)

- no estimated use
- 0.001 to 0.003
- 0.004 to 0.016
- 0.017 to 0.088
- 0.089 to 0.645
- >= 0.646

Crops	Total pounds applied	Percent national use
cotton	350964	49.23
potatoes	189011	26.51
mint for oil	49651	6.96
dry onions	38703	5.43
tomatoes	19751	2.77
citrus fruit	13542	1.90
celery	13137	1.84
apples	9029	1.27
carrots	8772	1.23
bell peppers	5140	0.72

Figure 3.1. National Agricultural Usage of Oxamyl in 2002 (USGS, 2010).

U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) Census of Agriculture data from 2002 and 2007 are listed in **Table 3.2** to describe the spatial extent of the crops analyzed in this *assessment* (USDA, 2010*a*). The majority (83%) of celery acreage in 2007 was located in California, with 6.6% in Michigan, and either much less or unreported amounts in other states. The majority (43%) of peanuts acreage was located in Georgia. Although pears are grown all over the United States, Washington (37%), Oregon (27%), and California (23%) collectively accounted for 87% of pear acreage. The majority of eggplant acreage (69%) was located in California (20%), Florida (19%), New Jersey (16%), and Georgia (14%), although eggplant production was reported in every state of the Union.

Table 3.2. Area of Harvested Crops in the United States (USDA, 2010*a*).[A]		
Crop	**Area Harvested in 2007 (acres)**	**Area Harvested in 2002 (acres)**
Plantains	(not available)	(not available)
Bananas	2,547	1,975
Celery	29,907	28,241
Eggplant	6,038	6,401
Ginger Root	>80 (value is undisclosed)	185
Peanuts	1,200,564	1,223,093
Pears	68,216	80,801
Pineapple	>35 (value is undisclosed)	6,978
Sweet potatoes	105,284	92,310
Tobacco	359,846	428,631
Yams	(not available)	(not available)

A These data exclude values from Puerto Rico and other U.S. Territories.

According to the 2007 Census of Agriculture, national acreage of harvested ginger root in 2007 consisted of 80 acres in Hawai'i, 42 acres in Puerto Rico, and an undisclosed number of acres in Kentucky (hence, the undisclosed national value in **Table 3.2**; USDA, 2010*a*). Within the State of Hawai'i, the majority of production (51 acres) occurred on the big island. Production has declined over the years, with only 60 acres harvested in 2008 (the lowest acreage in 28 years) and 50 acres expected to be planted for harvest in 2009 (USDA, 2010b).

In 2006, pineapple production had declined as well, although at a much slower rate in Hawai'i than the decline in production of ginger root. 13,900 acres were planted in Hawai'i in 2006, compared to 19,100 acres planted in 2002 (USDA, 2010c). Declining pineapple production was reported in Puerto Rico as well: 320 acres were harvested in 2007 compared to 2,270 acres in 2002 (USDA, 2010d).

In Puerto Rico, plantain is a major crop, with 17,513 acres planted in 2007 (down from 25,814 acres in 2002; USDA, 2010d). Census of Agriculture data for crops in Puerto Rico that were considered in this assessment are listed in **Table 3.3** (USDA, 2010d). Of the crops analyzed in this assessment, eggplant and ginger root were the only two that were increasing in production in Puerto Rico in 2007 relative to 2002.

Table 3.3. Area of Harvested Crops in Puerto Rico (USDA, 2010d).		
Crop	**Area Planted in 2007 (acres)**	**Area Planted in 2002 (acres)**
Plantains	17,513	25,814
Bananas	6,812	10,751
Pineapple	320	2,270
Yams	1,246	1,419
Sweet potatoes	290	626
Eggplant	591	302
Ginger root	42	Not reported

In contrast with the 2009 assessments, reported (*i.e.*, "actual") use patterns based on usage data provided by BEAD were not modeled in this assessment to characterize reductions in exposure estimates that would result from potential changes to the maximum labeled use patterns.

3.2. Environmental Fate and Transport Characterization

Oxamyl [(*EZ*)-*N*,*N*-dimethyl-2-methylcarbamoyloxyimino-2-(methylthio)acetamide; CAS# 23135-22-0; PC Code 103801] is hydrophilic, mobile to highly mobile in soil, and relatively nonvolatile (see **Figure 3.2** for chemical structure). The compound dissipates in the environment by chemical (abiotic) and microbially-influenced (biotic) degradation and by leaching (**Table 3.4**). Oxamyl degrades rapidly in alkaline water bodies and anaerobic, iron-rich, saturated sub-soils (*i.e.*, subterranean soils below the water table). Degradation half-lives are on the order of days in most soils and in neutral water bodies; however, oxamyl persists for weeks in some soils and may persist for months to years in some aerobic, acidic, saturated sub-soils (oxamyl is slow to hydrolyze in acidic environments). Degradation in acidic water bodies is uncertain because anaerobic aquatic metabolism data are not available for surface soils and the submitted aerobic aquatic metabolism study was conducted at pH 6.6 to 8.3, pH values at which hydrolysis is expected to dominate degradation. Oxamyl may leach to ground water or move to surface water bodies through spray drift and/or dissolved in runoff. The compound is not expected to bioaccumulate in aquatic or terrestrial organisms. Further description of the environmental fate of oxamyl is found in the preliminary problem formulation for the registration review of oxamyl (DP barcode 368178; USEPA 2010).

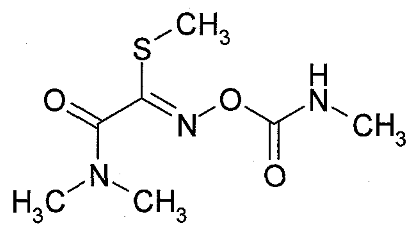


Figure 3.2. Structure of Oxamyl.

Table 3.4. General Chemical Properties and Environmental Fate Parameters of Oxamyl.		
Parameter	**Value**	**Reference**
Physical/Chemical Parameters		
Molecular mass	219.3 g/mol	MRID 40499702
Vapor pressure (25°C)	3.84×10^{-7} torr	MRID 42526101
Water solubility (20°C)	2.82×10^{5} mg/L	MRID 40499702
Octanol-water partition coefficient (K_{OW})	0.36	MRID 40499702
Persistence in Water		
Hydrolysis half-life	pH 5: Stable pH 7: 8.0 d pH 9: 0.12 d	MRID 40606516
	pH 4.66: >413 d pH 5.55: 214 d pH 6.09: 63.3 d pH 6.57: 21.4 d pH 6.85: 11.5 d pH 7.10: 6.46 d pH 7.40: 3.43 d pH 7.66: 1.91 d pH 7.95: 1.03 d pH 8.44: 0.341 d pH 8.91: 0.123 d pH 8.92: 0.115 d pH 9.43: 0.0357 d pH 9.92: 0.0152 d	Strathmann and Stone, 2002 (half-life values calculated from rate constants)
Aqueous photolysis half-life	14.2 d (pH 5)	MRID 40606515; 41058801
Aerobic aquatic metabolism half-life	3.4 d; hydrolysis-corrected: stable (sandy loam, pH 6.6-7.8) 3.5 d; hydrolysis-corrected: stable (sandy loam, pH 6.9-8.3)	MRID 45045305
Persistence in Soil		
Soil photolysis half-life	No evidence of degradation	MRID 147704
Aerobic soil metabolism half-life	11 d (silt loam, pH 6.4, OM 2.8%) 17 d (silt loam, pH 6.4, OM 2.8%)	MRID 63012
	11 d (sandy clay loam, pH 7.7, OM 1.5%)	MRID 42820001
	2.9 d (silt loam, pH 7.0, OM 0.4%) 4.6 d (silt loam, pH 7.8, OM 2.1%) 112 d (silty clay loam, pH 4.8, OM 4.4%)	MRID 45176602
Anaerobic soil metabolism half-life	5.8 d (sandy clay loam, pH 7.7, OM 1.5%)	MRID 42820001
Persistence in Saturated Sub-Soil		
Aerobic saturated sub-soil half-life	67.5 d (sand sub-soil; pH 5.8-6.6) 1,200 d (sand sub-soil; pH 4.4-5.0)	MRID 45176601
Anaerobic saturated sub-soil half-life	ND[A] (loamy sand sub-soil; pH 4.2-4.7) <6 hrs (sand sub-soil; pH 4.4-5.0)	MRID 45176601
Mobility		
Organic carbon partitioning coefficient (K_{OC})	10-60 L/kg_{OC} (5 soils)	MRID 46237301
	6-10 L/kg_{OC} (3 soils)	Bilkert and Rao, 1985
	2.5-8.7 L/kg_{OC} (6 soils)	Bromilow *et al.*, 1980

Table 3.4. General Chemical Properties and Environmental Fate Parameters of Oxamyl.			
Parameter	**Value**		**Reference**
Column leaching (% parent in leachate; % identified residues in leachate)	<0.2-83%; 89-100% (6 un-aged soils)		MRID 141395
	21-50%; 37-67% (3 aged soils)		MRID 40606514
Field Dissipation			
Terrestrial field dissipation half-life	3 d (FL), 4 d (CA), 19 d (WA)	(Oxamyl detected at deepest sample depths of each study.)	MRID 41573201; 41963901
	8.6 d (MS)		MRID 45045304

A ND means "not detected" (at any sampling event).

A substantial difference in the environmental fate data used in this assessment relative to previous assessments is the inclusion of hydrolysis rates from Strathmann and Stone (2002). These rates are consistent with the rates reported in the submitted hydrolysis study (MRID 40606516). Strathmann and Stone investigated hydrolysis of oxamyl at 16 pH values ranging from 2.07 to 9.92 and at a range of pH values in the presence of ferrous iron or other inorganic ligands. Above approximately pH 5, the hydrolysis rate of oxamyl increased relatively proportionally to the decrease in proton concentration (*i.e.*, the hydrolysis half-life decreased by an order of magnitude for every increase of pH by 1).

The Strathmann and Stone (2002) data were used in this assessment to indicate that aerobic aquatic metabolism is negligible when corrected to account for hydrolysis. In previous assessments, aerobic aquatic metabolism half-lives from MRID 45045305 (~3.5 days) were corrected for hydrolysis at pH 7 (using data from MRID 40606516), resulting in biodegradation half-lives of 6.1-6.3 days. However, when the correction for hydrolysis is made using hydrolysis rates (from Strathmann and Stone, 2002) at the time-adjusted mean pH values (7.96 and 7.72) of the water column in the study systems, all degradation is accounted for by hydrolysis (*i.e.*, the degradation rate in the water column at pH 7.96 or 7.72 is less than or equivalent to the hydrolysis rate at similar studied pH values (7.95 or 7.66, respectively). Therefore, aerobic aquatic biodegradation is negligible when corrected to account for hydrolysis. This results in insubstantial increases in peak exposure estimates and in approximate doubling of time-averaged exposure estimates, as explained in **Section 3.3.1.2** below.

3.2.1. Residues of Concern

Oxamyl alone is the residue of concern in this assessment. The major degradates identified in the IRED, oxamyl oxime and DMOA, were not determined to be of toxicological concern (USEPA, 2000). The remaining major degradates of oxamyl, DMCF and DMEA, are possible degradates of oxamyl oxime and are not structurally similar to oxamyl parent. Therefore, they are not considered to be of toxicological concern.

3.3. Drinking Water Exposure Modeling

Estimated drinking water concentrations (EDWCs) were generated using the Tier II exposure models Pesticide Root Zone Model (PRZM v3.12.2; May 12, 2005; Carousel *et al.*, undated) and EXposure Analysis Modeling System (EXAMS v2.98.4.6; Apr. 25, 2005; Burns, 2004), linked via the PRZM/EXAMS model shell (PE v5.0, Nov. 15, 2006) when scenarios or surrogate scenarios were available for modeled uses. Otherwise, EDWCs were generated using the Tier I FQPA Index Reservoir Screening Tool (FIRST v1.1.1, Mar. 26, 2008; USEPA, 2008). The PRZM model simulates pesticide movement and transformation on and across the agricultural field resulting from crop applications. The EXAMS model simulates pesticide loading via runoff, erosion, and spray drift assuming a standard watershed of 172.8 ha that drains into an adjacent standard drinking water index reservoir of 5.26 ha, an average depth of 2.74 m. A more detailed description of the index reservoir watershed can be found in Jones *et al.*, 1998. One-in-ten-year peak and annual mean EDWCs are generated to estimate acute and chronic exposure. 30-year mean EDWCs are also generated for evaluation of carcinogen exposure. The coupled PE models and users manuals may be downloaded from the U.S. Environmental Protection Agency (USEPA) Water Models web-page (USEPA, 2010*a*).

FIRST is a Tier I screening model that simulates the upper-end exposure of the standard drinking water index reservoir to pesticide residues in runoff and spray drift from an application within the standard watershed. Peak and annual mean EDWCs are generated to estimate acute and chronic exposure. The FIRST model and user's manual are available from the EPA Water Models web-page (USEPA, 2010*a*).

Default Percent Cropped Area (PCA) values (both national and regional) that account for the maximum area within a watershed that may be planted with the modeled crop are applied to exposure estimates. FIRST applies PCA values internally. Exposure estimates produced by PE are manually adjusted with PCA values (*i.e.*, post-processed).

3.3.1. Input Parameters

3.3.1.1. Tier I Modeling

FIRST was used to estimate screening level exposure in surface water from use of oxamyl on yams (labeled for Puerto Rico only), ginger root (labeled for Hawai'i only), and pineapple (label prohibits use in California; grown in Hawai'i and Puerto Rico). Other assessed uses were modeled with the Tier II PE model because PRZM scenarios or reasonable surrogate PRZM scenarios were available. Model input parameters used in FIRST are listed in **Table 3.5**. Chemical property input values were chosen in accordance with current input parameter guidance (USEPA, 2009c).

Table 3.5. FIRST Input Parameters for Oxamyl Uses on Yams, Ginger Root, and Pineapple.			
Input Parameter	**Value**	**Comments**	**Source**
Application rate (lbs a.i./A)	Ginger: 1.0 Pineapple: 2.0 Yams: 0.5	Maximum labeled single application rate for post-plant or foliar treatment	Current label
Number of applications per year	Ginger: 8 Pineapple: 4 Yams: 8	Maximum labeled number of applications per season (either explicit or inferred from the maximum seasonal application rate)	Current label
Re-application interval (days)	Ginger: 30 Pineapple: 14 Yams: 14	Minimum labeled re-application intervals	Current label
Percent cropped area	100%	Default for uses outside of the contiguous United States	Effland *et al.*, 1999
Organic Carbon Partition Coefficient (K_{OC}) (L/kg$_{OC}$)	35	Mean of five K_{OC} values	MRID 46237301
Aerobic soil metabolism half-life (days)	52	Upper 90% confidence bound on the mean of six half-lives	MRID 63012 MRID 42820001 MRID 45176602
Wetted in?	No	Input recommended in divisional guidance	USEPA, 2009c
Method of application	Ground	Modeled use patterns are for foliar ground applications.	Current label
Depth of incorporation (inches)	0	Foliar applications are not incorporated.	Current label
Solubility in water (ppm)	280,000	Product chemistry data	MRID 40499702
Aerobic aquatic metabolism half-life (days)	0	At the study pH levels, aqueous degradation was indistinguishable from that due to hydrolysis.	MRID 45045305
Hydrolysis half-life (days)	8.0	Half-life at pH 7	MRID 40606516
Aqueous photolysis half-life (days)	14	Maximum environmental phototransformation half-life	MRID 40606515; 41058801

Standard percent cropped areas (PCA) are used as conservative default estimates of the extent of watershed on which agricultural crops of unknown specific PCA are grown (Effland *et al.*, 1999). However, PCA values are not available for areas outside of the contiguous United States. Therefore, PCA values were not applied to exposure estimates for these uses that are labeled exclusively for Hawai'i (ginger root) or Puerto Rico (yams) or will predominantly occur on these island locations (pineapple).

3.3.1.2. Tier II Modeling

Chemical Inputs

The general chemical and environmental fate data for oxamyl listed in **Table 3.4** were used for generating model input parameters for PE (listed in **Table 3.6**). These inputs were determined in accordance with current guidance (USEPA, 2009c). Input values are largely the same as in the previous assessments, with two exceptions: 1) the aerobic aquatic metabolism half-life input was set to zero because degradation was not observed beyond that expected due to hydrolysis alone in the submitted aerobic aquatic metabolism study, and 2) a calculated Henry's Law Constant was input rather than a vapor pressure. The use of the Henry's Law Constant is consistent with guidance and does not alter exposure estimates. The new aerobic aquatic metabolism input results in a small increase in 1-in-10-year peak EDWCs and larger increases in time-averaged EDWCs because stability to aquatic metabolism results in less degradation over time in the index reservoir. For example, the 1-in-10-year peak (300 µg/L), 1-in-10-year annual mean (6.4 µg/L), and 30-year mean (2.7 µg/L) EDWCs for the maximum use pattern (carrots) of the drinking water exposure assessments conducted in 2009 (DP barcode 351367; USEPA, 2009 and DP barcode 363404; USEPA, 2009a) are increased with the new aerobic aquatic metabolism input to 303 µg/L, 12 µg/L, and 5.3 µg/L, respectively. To summarize, the 1-in-10-year peak estimates are not substantially different, while the time-averaged estimates are approximately doubled.

Table 3.6. PE Chemical Input Parameters for Oxamyl.			
Input Parameter	**Value**	**Comment**	**Source**
Molecular Mass (g/mol)	219	Product chemistry data	MRID 40499702
Henry's Law Constant (atm m^3/mol)	3.9×10^{-13}	Product chemistry data	Calculated from MRID 42526101, 40499702
Solubility in Water (mg/L)	2.8×10^5	Product chemistry data	MRID 40499702
Organic Carbon Partition Coefficient (K_{OC}) (L/kg_{OC})	35	Mean of five K_{OC} values	MRID 46237301
Aerobic Soil Metabolism Half-life (days)	52	Upper 90% confidence bound on the mean of six half-lives	MRID 63012 MRID 42820001 MRID 45176602
Aerobic Aquatic Metabolism Half-life (days)	0	Aqueous degradation is indistinguishable from that due to hydrolysis.	MRID 45045305
Anaerobic Aquatic Metabolism Half-life (days)	0	Assumed stable in the absence of data. Aqueous degradation will be dominated by hydrolysis.	Not applicable
Hydrolysis Half-life (days)	8.0	Half-life at pH 7	MRID 40606516
Aqueous Photolysis Half-life (days)	14	Maximum environmental phototransformation half-life	MRID 40606515; 41058801

Use Pattern Inputs

The model input parameters used in PRZM to simulate oxamyl application and crop management practices are provided in **Table 3.7**. Application timing of oxamyl is related to various pest pressures. Initial application dates were selected in order to reflect labeled crop timing for applications, consistent with the crop timing set by the model scenarios and with crop-profile information provided by the United States Department of Agriculture (USDA, 2010).

Table 3.7. PRZM Scenarios and Input Parameters Describing Maximum Oxamyl Use Patterns.								
Use	**Scenario**	**Date of Initial App.**	**App. Rate (lbs a.i./A)**	**App. per Year**	**App. Interval (days)**	**CAM Input**	**IPSCND Input**	**Application Efficiency/ Spray Drift**
Banana/plantain	PR coffee STD	Sep. 1	4.0	1	N/A	1	3	0.99/0.064
Celery	CA row crop RLF	Jan. 15	1.0	6	5	2	1	0.95/0.16
	FL cabbage STD							
	FL cabbage STD	Jan. 15	2.0	3	21			0.99/0.064
Eggplant	CA row crop RLF	Jan. 15	1.0	6	7	2	1	0.99/0.064
	CA tomato STD	Jul. 15						
	FL tomato STD	Apr. 1						
	FL pepper STD	Apr. 1						
	PA tomato STD	Jul. 15						
	PA vegetable NMC	Aug. 1						
	STX vegetable NMC	Jan. 15						
	FL tomato STD	Feb. 1	2.0, 1.0[A]	4	28, 14, 7[A]	2[A]		
	FL pepper STD	Sep. 1						
	PA tomato STD	Apr. 16						
	PA vegetable NMC	May 10						
	STX vegetable NMC	Oct. 1						
Peanut	NC peanut STD	May 30	0.5	8	14, 5[B]	2	1	0.95/0.16
Pear (bearing fruit)	PA apple STD	Mar. 1	2.0	1	N/A	2	3	0.99/0.063
	NC apple STD							
	OR apple STD							
	WA orchard NMC							
	TX orchard BSS							
Sweet potato	FL potato NMC	Dec. 13	2.0, 4.0[C]	2	5[C]	4[C]	1	0.99/0.064
	NC sweet potato STD	Apr. 26						
Tobacco	NC tobacco STD	Apr. 15	2.0	1	N/A	4[D]	2	0.99/0.064

A Initial two applications at 2.0 lbs a.i./A are soil treatments 28 days apart. Two foliar applications at 1.0 lb a.i./A, 7 days apart, follow 14 days after the initial two soil applications (CAM value set to 2 for all applications).

B Interval of 14 days is labeled for the second application. Interval of 5 days is assumed for following applications in the absence of a labeled value.

C The initial application is 2.0 lbs a.i./A incorporated to a 10-cm-depth, followed by an application at 4.0 lbs a.i./A applied in-furrow at transplant (CAM value set to 4 for all applications). Interval of 5 days is assumed in the absence of a labeled value.

D Application is incorporated to a 10-cm depth.

Multiple scenarios were modeled, if available, for each use, in order to provide exposure estimates relevant to regions of the United States. These regions are large because there are a limited number of scenarios per use, which requires the few scenarios to act as surrogates for large areas of the United States. The Puerto Rico coffee scenario was used as a surrogate for bananas and plantains because coffee, plantains, and bananas are grown in mountainous zones of

Puerto Rico with steep slopes that the scenario simulates. The Florida cabbage and California row crop scenarios were used to model use on celery because they were designed for modeling leafy vegetables. All scenarios for fruiting vegetables were used to model use on eggplant. Apple and orchard scenarios were used to model oxamyl use on pears. Potato and sweet potato scenarios in the Southeastern United States were used to model use on sweet potatoes, which are not widely grown in the Pacific Northwest. Two different use patterns were modeled for use on celery and for use on eggplant because of geographic limitations on each use pattern (*e.g.*, the first use patterns are allowed in California, while the second use patterns are not).

PE exposure estimates for uses within the contiguous United States were multiplied by the default national percent cropped area factor (PCA), which is 87% (Effland *et al.*, 1999). PE exposure estimates for uses constrained to Hawai'i and/or Puerto Rico were not adjusted by a PCA value because PCA values are not available for these areas.

Regional PCA Refinement

A previous dietary risk assessment determined that dietary levels of concern (for food plus water and accounting for number of eating occasions per day) were not exceeded when EDWC time series were represented by a 1-in-10-year peak value below 80 µg/L (personal communication with Sheila Piper, Nov. 19, 2008). Therefore, this refinement focused on uses within the contiguous United States with initial acute exposure estimates that exceeded 80 µg/L. These uses (on celery and eggplant) were refined by applying default regional PCA values that account for the highest extent of HUC-8 watershed in the HUC-2 regions on which agricultural crops are grown (Effland *et al.*, 1999). **Figure 3.3** displays the 18 regions (or HUC-2 watershed basins) of the contiguous United States for which regional PCA factors were calculated. This refinement could not be conducted with Tier I or Tier II exposure estimates for uses constrained to Hawai'i and/or Puerto Rico because PCA values, including regional PCA values, are not available for these areas.

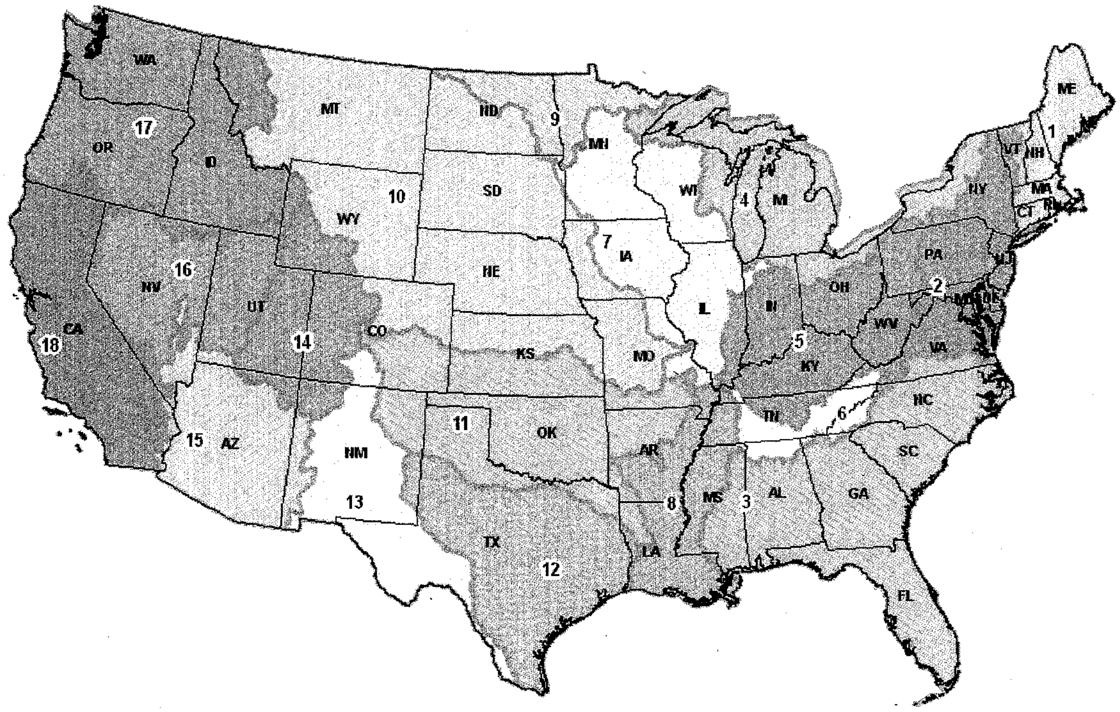


Figure 3.3. The Eighteen HUC-2 Watershed Basins of the Contiguous United States.

The first step of this refinement process was to use 2007 AgCensus data to ascertain the states in which the crops analyzed for refinement (*i.e.*, celery and eggplant) were grown (USDA, 2010*a*). These data indicated that celery is grown in all but four of the contiguous 48 states and that eggplant is grown in every state. The second step of this process was to identify in which of these states oxamyl is labeled for use. Use on celery is limited to within the States of Arizona, California, Florida, Ohio, Pennsylvania, Michigan, and Texas; whereas, use on eggplant is not geographically limited. Therefore, oxamyl may be applied to celery in eleven PCA regions and to eggplant in all eighteen PCA regions. However, as stated before, the vast majority of celery is grown in California (83%), with 6.6% grown in Michigan and the majority of eggplant is grown in California (20%), Florida (19%), New Jersey (16%), and Georgia (14%).

The third step of this refined analysis was to assign a PRZM scenario for modeling each use-PCA region combination where oxamyl might be applied (**Table 3.8**). The strategy for assigning surrogate model scenarios was to use current scenarios to represent areas of similar meteorological and agronomic conditions. For celery, the California row crop scenario was used to represent regions of the United States west of the Continental Divide and the Florida cabbage scenario was used to represent regions of the United States east of the Continental Divide. For eggplant, the California tomato scenario was used for regions west of the Continental Divide. The Florida pepper scenario was used for the Southeastern United States. The Pennsylvania tomato scenario was used for the Northeastern United States and Northern Mid-West. And the

South Texas vegetable scenario was used for the Southern Mid-West. Following the assignment of model scenarios to each use-PCA region combination, the modeling was conducted and the regional PCA-adjusted 1-in-10-year peak EDWCs were tabulated for each combination of use and PCA region (listed in **Table 3.12**), as discussed in the Modeling Results section below.

Table 3.8. Scenario Assignments for Regional PCA Assessment.

Major Basin #	Basin Name	Regional PCA	States Where Use on Celery is Labeled	Scenario Assignments for Celery	Scenario Assignments for Eggplant
East of Eastern Divide					
1	New England	14			PA tomato STD
2	Mid Atlantic	46	PA	FL cabbage STD	PA tomato STD
3	South Atlantic	38	FL	FL cabbage STD	FL pepper STD
Mid-Continent (Mississippi River Basin)					
4	Great Lakes	77	OH, MI	FL cabbage STD	PA tomato STD
5	Ohio	82	OH, PA	FL cabbage STD	PA tomato STD
6	Tennessee	38			FL pepper STD
7	Upper Mississippi	85			PA tomato STD
8	Lower Mississippi	85			STX vegetable NMC
9	Souris	83			PA tomato STD
10	Missouri	87			PA tomato STD
11	Arkansas	80	TX	FL cabbage STD	STX vegetable NMC
12	Texas Gulf	67	TX	FL cabbage STD	STX vegetable NMC
13	Rio Grande	28	TX	FL cabbage STD	STX vegetable NMC
West of Western Divide					
14	Upper Colorado	7	AZ	CA row crop RLF	CA tomato STD
15	Lower Colorado	11	AZ	CA row crop RLF	CA tomato STD
16	Great Basin	28	CA	CA row crop RLF	CA tomato STD
17	Pacific Northwest	63			CA tomato STD
18	California	56	CA	CA row crop RLF	CA tomato STD

3.3.2. Modeling Results

Current use patterns were modeled to estimate surface water exposure, as described above. Results from the Tier I analysis of uses on ginger, pineapple, and yams are followed below by the results from Tier II analysis of uses on banana/plantains, celery, eggplant, peanuts, pears, sweet potatoes, and tobacco.

3.3.2.1. Tier I Results

Screening acute and chronic exposure estimates in surface water drinking water sources from FIRST are listed in **Table 3.9**. Use on pineapple resulted in the highest estimated peak exposure (593 μg/L).

Table 3.9. Tier I Estimated Drinking Water Concentrations (EDWCs) from Use of Oxamyl on Ginger, Pineapple, or Yams (values >80 µg/L are bolded).		
Use (modeled rate)	**Peak (µg/L)**	**Annual Mean (µg/L)**
Ginger (8.0 lbs a.i./A/year)	279	6.6
Pineapple (8.0 lbs a.i./A/year)	593	14
Yams (4.0 lbs a.i./A/year)	218	5.1

Exposure Characterization with Provisional PE Scenarios

Because Tier I modeling of the uses on ginger root, pineapple, and yams produced peak exposure estimates >80 µg/L, a provisional Tier II modeling approach was used to characterize potential refinement of these estimates. Unrelated scenario and metfile data were paired for modeling because surrogate PRZM scenarios were not available for these uses in Hawai'i or Puerto Rico but meteorological data (*i.e.*, "metfiles") were available for locations near where the modeled crops are grown. Modeling local metfiles was expected to increase the representativeness of modeled surrogate scenarios because the PE model is sensitive to precipitation. Therefore, the metfile for Hilo, Hawai'i (w21504) was used to model use on ginger root grown in Hawai'i, since it is near where most ginger root is grown on the Hawaiian Islands (USDA, 2010e). The metfile for San Juan, Puerto Rico was used for yams grown in Puerto Rico because it is the only metfile available for the Territory. And lastly, because pineapple is grown in both Puerto Rico and Hawai'i (but mostly on Oahu and Maui), metfiles for San Juan, Puerto Rico; Honolulu, Hawai'i; and Kahului, Hawai'i were used to model use on pineapple.

Surrogate PRZM scenarios were selected for this provisional modeling refinement based on crop similarity and without regard to location because local surrogate scenarios were not available. More specifically, the Florida potato scenario was used to model use on ginger root and yams and the Florida cabbage scenario was used to model use on pineapples. These surrogate scenarios were selected for modeling rather than other potato or row crop scenarios because their vulnerability to runoff is higher than that of other scenarios (with the exception of that of the South Texas vegetable scenario).

Table 3.10 lists the PRZM scenarios, metfiles, and input parameters that were used for this provisional refinement. Two use patterns were modeled for use on ginger root in order to evaluate exposure from different application methods and timing. The first use pattern is a per-plant application of 4.0 lbs a.i./A that is incorporated to a depth of 5 cm. The second use pattern is eight foliar (post-emergent) applications of 1.0 lb a.i./A, 30-days apart.

Table 3.10. PRZM Scenarios, Meteorological Files, and Input Parameters for Tier II Characterization of Tier I Modeled Use Patterns.									
Use	**Scenario**	**Metfile Location**	**Date of Initial App.**	**App. Rate (lbs a.i./A)**	**App. per Year**	**App. Interval (days)**	**CAM Input**	**IPSCND Input**	**Application Efficiency/ Spray Drift**
Ginger root	FL potato NMC	Hilo, HI	Dec. 15	4.0	1	None	4[A]	1	0.99/0.064
			Jan. 15	1.0	8	30	2		
Pineapple	FL cabbage STD	Honolulu, HI	Oct. 16	2.0	4	14	2	1	0.99/0.064
		Kahului, HI							
		San Juan, PR							
Yams	FL potato NMC	San Juan, PR	Jan. 1	0.5	8	14	2	1	0.99/0.064

A Application is pre-plant at 4.0 lbs a.i./A, incorporated (CAM 4) to a 5-cm minimum depth.

Exposure estimates from this provisional refinement are listed for characterization in **Table 3.11**. The results indicate that the Tier I exposure estimates were not unreasonably conservative. In this refinement, peak EDWCs were reduced from 218 µg/L to 87 µg/L for use on yams and from 593 µg/L to 351 µg/L for use on pineapple. However, refined peak EDWCs for use on ginger root were increased from 279 µg/L to 392 µg/L. Refined EDWCs for each use remained above 80 µg/L. Also, if surface water drinking water intakes in Hawai'i and Puerto Rico are located in streams rather than reservoirs down-gradient from these uses, these EDWCs may underestimate the potential peak exposure and overestimate the potential time-averaged exposure resulting from these uses because less dilution will occur in the lower-volume streams that also provide less residence time than the modeled index reservoir. The relevance of the index reservoir to these situations is uncertain.

Table 3.11. Tier II Characterization of EDWCs from Use of Oxamyl on Ginger, Pineapple, or Yams (values >80 µg/L are bolded).					
Use (modeled rate)	**PCA[A]**	**PRZM Scenario/ Metfile**	**1-in-10 Year Peak (µg/L)**	**1-in-10-Year Annual Mean (µg/L)**	**30-Year Mean (µg/L)**
Ginger (8.0 lbs a.i./A/year)[B]	100%	FL potato NMC/ Hilo	**266**	6.7	2.2
			392	14	7.7
Pineapple (8.0 lbs a.i./A/year)	100%	FL cabbage STD/ Honolulu	**351**	13	5.2
		FL cabbage STD/ Kahului	**167**	7.3	3.0
		FL cabbage STD/ San Juan	**177**	7.1	3.7
Yams (4.0 lbs a.i./A/year)	100%	FL potato NMC/ San Juan	**87**	3.7	1.8

A The PCA for uses outside of the contiguous United States is 100%.

B The first row of EDWCs for the use on ginger result from the first use pattern listed in **Table 3.10**: one incorporated application of 4.0 lbs a.i./A. The second row of EDWCs results from the second use pattern listed in **Table 3.10**: eight foliar applications of 1.0 lb a.i./A, 30-days apart.

3.3.2.2. Tier II Results

Acute and chronic exposure estimates in surface water drinking water sources from PE are listed in **Table 3.12**. Exposure estimates for uses within the contiguous United States are adjusted by the default national PCA (87%). Exposure estimates for uses in other areas are not adjusted by PCA values because values are not available (*i.e.*, PCA=100%). Multiple exposure estimates are listed per use where multiple use patterns were modeled (as presented in **Table 3.7**). Oxamyl use on bananas/plantains, celery, and eggplant resulted in 1-in-10-year peak exposure estimates greater than 80 μg/L.

Table 3.12. Tier II PCA-adjusted EDWCs Resulting from Uses of Oxamyl (values >80 μg/L are bolded).					
Use (modeled rate)	**PCA[A]**	**PRZM Scenario**	**1-in-10 Year Peak (μg/L)**	**1-in-10-Year Annual Mean (μg/L)**	**30-Year Mean (μg/L)**
Banana/plantain (4.0 lbs a.i./A/year)	100%	PR coffee STD	**204**	6.3	2.3
Celery (6.0 lbs a.i./A/year)[B]	87%	FL cabbage STD	64	2.5	1.4
			146	5.5	2.9
Eggplant (6.0 lbs a.i./A/year)[B]	87%	FL pepper STD	**295**	9.9	4.3
			195	7.9	3.5
Peanut (4.0 lbs a.i./A/year)	87%	NC peanut STD	55	2.3	1.6
Pear (2.0 lbs a.i./A/year)	87%	NC apple STD	41	1.3	0.41
Sweet potato (6.0 lbs a.i./A/year)	87%	NC sweet potato STD	59	1.9	0.82
Tobacco (2.0 lbs a.i./A/year)	87%	NC tobacco STD	7.2	0.25	0.18

A The PCA is the default national PCA (87%) for uses within the contiguous United States and 100% for other areas for which PCAs are not available. EDWCs are adjusted by these PCAs.
B Multiple rows per use correspond to the multiple modeled use patterns that are listed in **Table 3.7**.

Guidance indicates that the hydrolysis rate at pH 7 (half-life of 8.0 days for oxamyl) should be modeled, which was done for exposure estimation. However, oxamyl is relatively stable to hydrolysis in acidic water bodies. Therefore, exposure estimates in acidic water bodies are expected to be higher than those modeled in this assessment. As an example, consider the use on plantains and bananas, crops that are mainly grown on soils of pH 4.5-5.5 in Puerto Rico (USDA, 2010). If exposure is estimated using hydrolysis rates at pH 5 or 6, exposure estimates increase as shown in **Table 3.13**.

Table 3.13. Exposure Estimates for Oxamyl Use on Plantains/bananas Using Hydrolysis Half-lives for Environments at pH 5, 6, or 7.				
Environmental pH	**Hydrolysis Half-life (days)**	**1-in-10 Year Peak (μg/L)**	**1-in-10-Year Annual Mean (μg/L)**	**30-Year Mean (μg/L)**
7	8.0	204	6.3	2.3
6	63	209	31	12
5	Stable	222	69	28

Regional PCA Refinement

As stated above, regional PCA-adjusted 1-in-10-year peak EDWCs were tabulated for each combination of use and HUC-2 watershed basin for uses within the contiguous United States for which initial EDWCs exceeded 80 μg/L (*i.e.*, celery and eggplant; **Table 3.14**). This refinement indicates that exceedances may occur in the Mississippi River Basin for both use on celery and use on eggplant. The South Atlantic Basin also may have exceedances resulting from use on eggplant. Refined exposure estimates did not exceed 80 μg/L along the mid-Atlantic seaboard, in the New England Region or west of the Continental Divide. Regional PCAs are not available to refine the exposure estimates for use on bananas/plantains.

Table 3.14. Regional PCA-refined 1-in-10-year Peak EDWCs for Oxamyl Use on Celery or Eggplant.

Major Basin #	Basin Name	Regional PCA	Scenario Assignments for Celery	Celery EDWCs (μg/L)	Scenario Assignments for Eggplant	Eggplant EDWCs (μg/L)
East of Eastern Divide						
1	New England	14	--	--	PA tomato STD	22
2	Mid Atlantic	46	FL cabbage STD	77	PA tomato STD	73
3	South Atlantic	38	FL cabbage STD	64	FL pepper STD	**129**
Mid-Continent (Mississippi River Basin)						
4	Great Lakes	77	FL cabbage STD	**129**	PA tomato STD	**122**
5	Ohio	82	FL cabbage STD	**138**	PA tomato STD	**130**
6	Tennessee	38	--	--	FL pepper STD	**129**
7	Upper Mississippi	85	--	--	PA tomato STD	**134**
8	Lower Mississippi	85	--	--	STX vegetable NMC	**237**
9	Souris	83	--	--	PA tomato STD	**131**
10	Missouri	87	--	--	PA tomato STD	**138**
11	Arkansas	80	FL cabbage STD	**134**	STX vegetable NMC	**223**
12	Texas Gulf	67	FL cabbage STD	**112**	STX vegetable NMC	**187**
13	Rio Grande	28	FL cabbage STD	47	STX vegetable NMC	78
West of Western Divide						
14	Upper Colorado	7	CA row crop RLF	5.5	CA tomato STD	4.5
15	Lower Colorado	11	CA row crop RLF	8.6	CA tomato STD	7.1
16	Great Basin	28	CA row crop RLF	22	CA tomato STD	18
17	Pacific Northwest	63	--	--	CA tomato STD	41
18	California	56	CA row crop RLF	44	CA tomato STD	36

With this regional refinement, use on eggplant remains the maximum use pattern evaluated in this assessment with Tier II models. The 1-in-10-year peak EDWC from use on eggplant is reduced with this refinement from 295 μg/L to 237 μg/L. The corresponding refined, time-average EDWCs for the maximum use pattern, eggplant, are a 1-in-10-year mean of 9.1 μg/L and a 30-year mean of 3.6 μg/L. The maximum refined 1-in-10-year peak, 1-in-10-year annual mean, and 30-year mean EDWCs for use on celery are 138 μg/L, 5.2 μg/L, and 2.7 μg/L, respectively.

3.4. Monitoring Data

The available monitoring data are discussed in the 2009 assessment for the proposed use on sugar beets (DP barcode 351367; USEPA, 2009). These data suggest that oxamyl may be detected in surface water at up to 2.8 μg/L in vulnerable areas. Although oxamyl was not detected in most samples, the surface water monitoring studies did not target oxamyl use areas or times of known oxamyl use and, thus, may not necessarily reflect potential peak oxamyl concentrations that may occur in surface waters when runoff events occur shortly after oxamyl is applied. Changes in oxamyl detections due to label mitigations specified in the RED cannot yet be observed, as the RED mitigations were implemented in 2007, after which monitoring data are not yet available.

3.5. Drinking Water Treatment

According to the *N*-Methyl Carbamate Cumulative Risk Assessment, a review of available laboratory studies and monitoring data by the Agency indicates that conventional water treatment processes such as coagulation, sedimentation, and conventional filtration will not reliably remove or transform the *N*-methyl carbamates such as oxamyl in drinking water sources (USEPA, 2007*a*). However, lime softening will break down oxamyl through alkaline-catalyzed hydrolysis. Lime softening under either calcium- or magnesium-softening conditions reduced oxamyl concentrations by 99% (Miltner, 2005). Sorption on activated carbon using granular activated carbon (GAC) or powdered activated carbon (PAC) appears to be partially effective in removing oxamyl from drinking water (20 to 38% of oxamyl concentrations were removed; Speth and Miltner, 1990). Other treatment methods such as oxidation with chlorine, chloramines, chlorine dioxide, or potassium permanganate are not effective in reducing oxamyl concentrations, which is likely because the compound does not contain a methylthio group (Miltner, 2005).

Recently reviewed data on the oxidation of oxamyl in chlorinated surface source water at natural pH values (MRID 46214801) do not change exposure estimates in drinking water because oxidation was not rapid (half-lives of 67.9 to 123 hours) with respect to residence time in treatment and delivery systems.

4. CONCLUSIONS

Tier I surface water drinking water acute (peak) exposure estimates for oxamyl use on ginger, pineapples, and yams in Hawai'i and/or Puerto Rico ranged from 218 to 593 μg/L with up to 14 μg/L estimated for chronic exposure (**Table 3.9**). The Tier II acute (1-in-10-year peak) exposure estimate for use on bananas and plantains in Puerto Rico was similar, at 204 μg/L (**Table 3.12**). Tier II acute exposure estimates for uses in the contiguous United States ranged up to 237 μg/L upon refinement with regional PCAs (**Tables 3.12 and 3.14**). Chronic (1-in-10-year annual mean) exposure estimates ranged up to 9.1 μg/L for Tier II modeling of uses in the contiguous United States.

Assessment modeling relied on maximum use patterns and regional PCA values, where available. Where actual use patterns are less than the labeled maximums, location-specific PCAs are less than assumed in this assessment, and drinking water is alkaline, actual environmental exposures may be lower. Similarly, where drinking water is acidic, actual environmental exposures may be higher. An additional source of uncertainty in this assessment is the representativeness of the modeled initial application dates.

Significant uncertainty is introduced into assessments for uses that occur in Hawai'i and Puerto Rico due to the lack of environmental fate data on the unique soils that occur in those locations and the lack of Tier II modeling scenarios and regional PCA refinements for those locations.

Monitoring data indicate that oxamyl has been detected in surface water at up to 2.8 μg/L in vulnerable areas. Lime softening reduces oxamyl concentrations in drinking water by 99% (Miltner, 2005); activated carbon filtration reduces oxamyl concentrations by only 20 to 38% (Speth and Miltner, 1990). Other drinking water treatment methods are not effective (USEPA, 2007*a*).

5. REFERENCES

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APPENDIX I. Model Output Samples.

The following are model outputs for FIRST and a sample model output for PE that represents the maximum modeled use pattern of oxamyl. The remaining PE outputs were not included due to their extensive collective size.

FIRST Output

```
RUN No.  1 FOR Oxamyl       ON  Ginger      * INPUT VALUES *
--------------------------------------------------------------------
 RATE (#/AC)  No.APPS &  SOIL  SOLUBIL  APPL TYPE  %CROPPED INCORP
  ONE(MULT)   INTERVAL   Koc  (PPM )  (%DRIFT)    AREA    (IN)
--------------------------------------------------------------------
 1.000( 2.910)  8  30       35.0*******     GROUND( 6.4) 100.0      0.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)
--------------------------------------------------------------------
METABOLIC  DAYS UNTIL  HYDROLYSIS  PHOTOLYSIS  METABOLIC  COMBINED
 (FIELD)  RAIN/RUNOFF  (RESERVOIR)  (RES.-EFF)  (RESER.)  (RESER.)
--------------------------------------------------------------------
 52.00          2              8.00           14.00- 1736.00   0.00           7.96

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.1.1  MAR 26, 2008
--------------------------------------------------------------------
    PEAK DAY  (ACUTE)    ANNUAL AVERAGE (CHRONIC)
     CONCENTRATION          CONCENTRATION
--------------------------------------------------------------------
           278.915                    6.560

RUN No.  2 FOR Oxamyl       ON  Pineapple    * INPUT VALUES *
--------------------------------------------------------------------
 RATE (#/AC)  No.APPS &  SOIL  SOLUBIL  APPL TYPE  %CROPPED INCORP
  ONE(MULT)   INTERVAL   Koc  (PPM )  (%DRIFT)    AREA    (IN)
--------------------------------------------------------------------
 2.000( 6.179)  4  14       35.0*******     GROUND( 6.4) 100.0      0.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)
--------------------------------------------------------------------
METABOLIC  DAYS UNTIL  HYDROLYSIS  PHOTOLYSIS  METABOLIC  COMBINED
 (FIELD)  RAIN/RUNOFF  (RESERVOIR)  (RES.-EFF)  (RESER.)  (RESER.)
--------------------------------------------------------------------
 52.00          2              8.00           14.00- 1736.00   0.00           7.96

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.1.1  MAR 26, 2008
--------------------------------------------------------------------
    PEAK DAY  (ACUTE)    ANNUAL AVERAGE (CHRONIC)
     CONCENTRATION          CONCENTRATION
--------------------------------------------------------------------
           593.259                   13.956
```

RUN No. 3 FOR Oxamyl ON Yams * INPUT VALUES *

```
--------------------------------------------------------------------
 RATE (#/AC)  No.APPS &  SOIL  SOLUBIL  APPL TYPE  %CROPPED INCORP
 ONE(MULT)   INTERVAL   Koc  (PPM )  (%DRIFT)    AREA    (IN)
--------------------------------------------------------------------
 0.500( 2.277)  8  14       35.0*******    GROUND( 6.4) 100.0      0.0
```

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

```
--------------------------------------------------------------------
METABOLIC  DAYS UNTIL  HYDROLYSIS  PHOTOLYSIS  METABOLIC  COMBINED
 (FIELD)  RAIN/RUNOFF  (RESERVOIR)  (RES.-EFF)  (RESER.)  (RESER.)
--------------------------------------------------------------------
 52.00        2            8.00           14.00- 1736.00   0.00         7.96
```

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.1.1 MAR 26, 2008

```
--------------------------------------------------------------------
   PEAK DAY  (ACUTE)    ANNUAL AVERAGE (CHRONIC)
    CONCENTRATION          CONCENTRATION
--------------------------------------------------------------------
         217.976                    5.126
```

PRZM/EXAMS Sample Output

stored as STXeggp-Jan15.out
Chemical: Oxamyl
PRZM environment: STXvegetableNMC.txt modified Thuday, 14 June 2007 at 09:18:16
EXAMS environment: ir298.exv modified Tueday, 26 August 2008 at 05:14:08
Metfile: w12919.dvf modified Tueday, 26 August 2008 at 05:14:24
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	206	171	89.41	36.52	24.66	6.486
1962	122	102	53.22	23.19	16.31	4.336
1963	39.46	33.42	19.99	8.425	5.658	1.902
1964	42.21	36.53	20.71	9.779	7.95	2.254
1965	45.42	40.01	22.9	10.28	7.021	2.178
1966	57.25	49.4	30.63	14	9.565	2.661
1967	85.43	71.17	37.13	16.78	12.12	3.192
1968	28	24.52	15.37	9.539	7.261	1.948
1969	184	153	81.06	34.71	23.9	6.605
1970	123	110	58.32	23.72	16.28	4.978
1971	113	93.99	49.03	21.47	14.52	4.039
1972	179	149	78.53	37.24	26.9	6.809
1973	287	239	180	79.09	53.8	13.38
1974	34.43	28.68	14.96	7.388	5.203	1.75
1975	17.11	14.28	8.858	4.148	2.784	1.186
1976	60.38	50.9	35.21	16.23	11.74	3.127
1977	330	277	145	58.87	39.39	11.19
1978	82.64	70.72	38.54	15.67	13.18	4.242
1979	21.95	18.29	11.71	5.252	3.972	1.346
1980	183	153	80.72	33.54	22.97	5.844
1981	337	291	153	62.16	42.98	10.87

1982	23.99	19.98	10.64	5.045	4.989	1.653
1983	74.48	62.05	34.08	17.22	12.16	3.048
1984	141	119	74.67	31.93	21.52	8.899
1985	13.79	12.09	6.812	2.937	3.056	0.9443
1986	57.67	48.05	25.54	11.02	7.394	2.279
1987	102	84.93	46.4	23.1	16.85	4.31
1988	66.63	55.51	30.96	18.22	15.02	3.911
1989	25.37	21.29	11.24	5.481	3.757	1.704
1990	10.8	8.996	4.694	3.197	3.059	0.8933

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	337	291	180	79.09	53.8	13.38
0.0645161290322581	330	277	153	62.16	42.98	11.19
0.0967741935483871	287	239	145	58.87	39.39	10.87
0.129032258064516	206	171	89.41	37.24	26.9	8.899
0.161290322580645	184	153	81.06	36.52	24.66	6.809
0.193548387096774	183	153	80.72	34.71	23.9	6.605
0.225806451612903	179	149	78.53	33.54	22.97	6.486
0.258064516129032	141	119	74.67	31.93	21.52	5.844
0.290322580645161	123	110	58.32	23.72	16.85	4.978
0.32258064516129	122	102	53.22	23.19	16.31	4.336
0.354838709677419	113	93.99	49.03	23.1	16.28	4.31
0.387096774193548	102	84.93	46.4	21.47	15.02	4.242
0.419354838709677	85.43	71.17	38.54	18.22	14.52	4.039
0.451612903225806	82.64	70.72	37.13	17.22	13.18	3.911
0.483870967741936	74.48	62.05	35.21	16.78	12.16	3.192
0.516129032258065	66.63	55.51	34.08	16.23	12.12	3.127
0.548387096774194	60.38	50.9	30.96	15.67	11.74	3.048
0.580645161290323	57.67	49.4	30.63	14	9.565	2.661
0.612903225806452	57.25	48.05	25.54	11.02	7.95	2.279
0.645161290322581	45.42	40.01	22.9	10.28	7.394	2.254
0.67741935483871	42.21	36.53	20.71	9.779	7.261	2.178
0.709677419354839	39.46	33.42	19.99	9.539	7.021	1.948
0.741935483870968	34.43	28.68	15.37	8.425	5.658	1.902
0.774193548387097	28	24.52	14.96	7.388	5.203	1.75
0.806451612903226	25.37	21.29	11.71	5.481	4.989	1.704
0.838709677419355	23.99	19.98	11.24	5.252	3.972	1.653
0.870967741935484	21.95	18.29	10.64	5.045	3.757	1.346
0.903225806451613	17.11	14.28	8.858	4.148	3.059	1.186
0.935483870967742	13.79	12.09	6.812	3.197	3.056	0.9443
0.967741935483871	10.8	8.996	4.694	2.937	2.784	0.8933
0.1	278.9	232.2	139.441	56.707	38.141	10.6729
			Average of yearly averages:			4.26548666666667

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:
Output File: STXeggp-Jan15

Metfile:	w12919.dvf			
PRZM scenario:	STXvegetableNMC.txt			
EXAMS environment file:	ir298.exv			
Chemical Name:	Oxamyl			
Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	219	g/mol	

Henry's Law Const.	henry	3.9e-13	atm-m^3/mol	
Vapor Pressure	vapr		torr	
Solubility	sol	2.8e5	mg/L	
Kd	Kd		mg/L	
Koc	Koc	35	mg/L	
Photolysis half-life	kdp	14	days	Half-life
Aerobic Aquatic Metabolism	kbacw	0	days	Halfife
Anaerobic Aquatic Metabolism	kbacs	0	days	Halfife
Aerobic Soil Metabolism	asm	52	days	Halfife
Hydrolysis:	pH 7	8.0	days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI		cm	
Application Rate:	TAPP	1.121	kg/ha	
Application Efficiency:	APPEFF	0.99	fraction	
Spray Drift	DRFT	0.064	fraction of application rate applied to pond	
Application Date	Date	15-01	dd/mm or dd/mmm or dd-mm or dd-mmm	
Interval 1	interval	7	days	Set to 0 or delete line for single app.
app. rate 1	apprate		kg/ha	
Interval 2	interval	7	days	Set to 0 or delete line for single app.
app. rate 2	apprate		kg/ha	
Interval 3	interval	7	days	Set to 0 or delete line for single app.
app. rate 3	apprate		kg/ha	
Interval 4	interval	7	days	Set to 0 or delete line for single app.
app. rate 4	apprate		kg/ha	
Interval 5	interval	7	days	Set to 0 or delete line for single app.
app. rate 5	apprate		kg/ha	
Record 17:	FILTRA			
	IPSCND	1		
	UPTKF			
Record 18:	PLVKRT			
	PLDKRT			
	FEXTRC	0.5		
Flag for Index Res. Run	IR	Reservoir		
Flag for runoff calc.	RUNOFF	total	none, monthly or total(average of entire run)	